ChessMate
Initial Design Review

Jeremiah Schultz
Philip Lo
Alex Babicz
Jason Dahn

Product Description

ChessMate is an interactive, LED illuminated chess board that enhances a player’s experience by providing various digital board augmentations. These include multicolor LEDs that automatically light up valid moves when a player picks up a piece, a touchscreen display that passively times each player as moves are made while displaying pertinent game information.

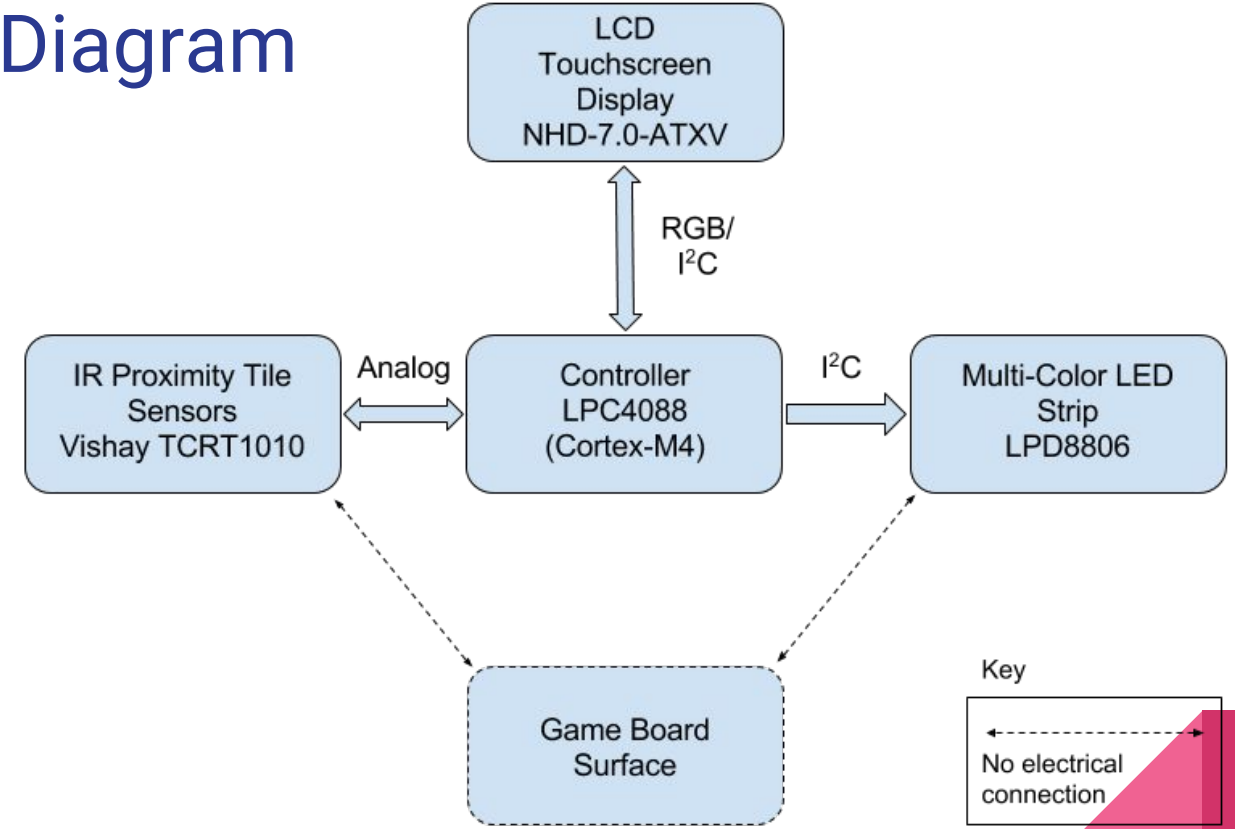
ChessMate Development Team

- Jeremiah Schultz (Leader): LCD interfacing and addressing, user interface design
- Philip Lo: Embedded software integration, board-logic
- Alex Babicz: LED and IR proximity sensor interfacing
- Jason Dahn: Board assembly, peripheral interfacing, software board memory
- All: PCB design, embedded development, enclosure assembly

Application & Usage

- Designed to help visualize chess moves on the playing surface
  - “Middle-man” between player’s thought-process and game-board
- Applicable to players of all skill levels
  - Assist new players in learning possible moves for each piece
  - Complement experienced user’s knowledge with visual representation
  - Toggle LED illuminations to practice/play without visualized moves enabled
- Simple touch LCD interface to combine simplicity and accessibility
  - Easily start/restart a new game with 1-button press
  - Track pieces that have been taken
  - Display last move made by each player

Block Diagram



Initial Specifications

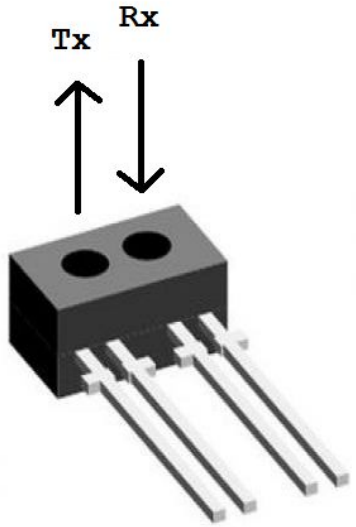
- Game Surface and Enclosure
  - Wooden box board enclosure to house entire unit
  - Indent on side panel of enclosure to mount LCD on the board
- Sensors
  - IR Proximity sensor: detects when a piece is picked from the board and moved to a new/same location on the game surface
- Multi-color LEDs
  - Visual representation of possible moves based on which piece is being used
  - Place beneath each game tile to illuminate specific squares
- LCD Touchscreen
  - User interface to start a new game
  - Displays passively timed clock for the game and player turns
  - Displays moves and pieces that have been taken

Processor - LPC4088 (with Cortex-M4 CPU)

- Memory: 512 kB flash, 96 kB RAM, 4k EEPROM
- Max clock speed: 120Mhz
  - Expected to operate at max speed
- Power: 2.4V - 3.6V supply voltage
  - 1.5W power dissipation
- Serial Interfaces: 5 UART, 3 I^2C, 3 SPI
  - Peripherals used require I^2C
- Analog peripherals: 12-bit ADC & 10-bit DAC
- Temp Range: -40 to +85 ^0C

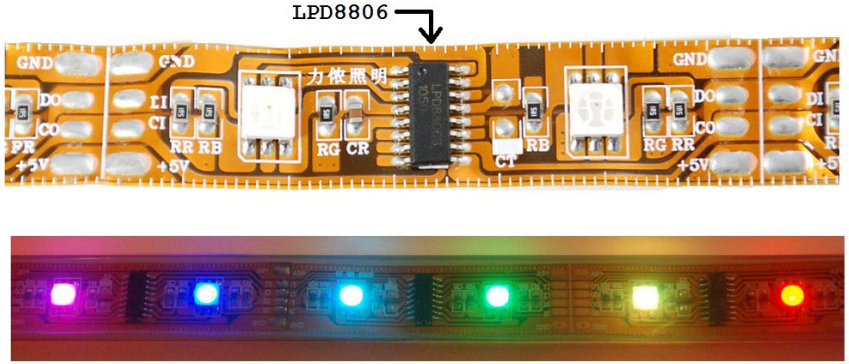
IR Proximity Sensor - Vishay TCRT1010

- Analog output
  - Convert to digital for simplicity
- Detection distance 1 - 10mm
  - Detect when piece has been picked up from surface
  - Daylight blocking filter
- 4 wires per sensor
  - 2 unique wires for each individual sensor
  - Common signals for 2 wires across all sensors
- Supply: 5V input voltage
  - 200 mW total power dissipation
- Average output current 0.5 mA



LED Strip - Adafruit Digital RGB LED Strip

- Connection via 4-pin JST SM connector
  - 8 connectors total for each row of tiles
- Digital I^2C interface
  - Individually control each LED
  - Cut strip into 8-LED increments
- Power: 5V Supply voltage
  - Max 5V @ 120 mA across one segment
    - One segment = 2 LEDs/1 LPD chip
- 16.5mm wide, 4mm thick
  - Sized to fit under each game tiles
  - 8x8 matrix of LED segment strips



NewHaven LCD Touchscreen - NHD-7.0-800480EF

- TFT 24-bit parallel RGB, Capacitive I^2C interface
- 16.7M colors
- 7” screen, 800 x 480 resolution
- Wide Viewing Angles (75º)
- TFT Power supply:
  - Vdd = 3.3V
  - Backlight Anode = 10 mA @ 9.6V
- Capacitive Touch Panel Power supply:
  - Vdd = 3.0 V
- Wide Temp Range: -20 to +70 ^0C

Current Bill of Materials

Manufacturer Part #	Description	Price	Distributor	Distributor Part #	Quantity	Total Price	Link
TCRT1010	IR Proximity Sensor	$0.76	DigiKey	751-1032-ND	75	$57.00	http://www.digikey.com/product-search/en?keywords=t
LPD8806	LED Strip (32 LEDs)	$30.00	Adafruit	306	3	$90.00	http://www.adafruit.com/products/306
LPC4088FBD208	LCP4088 Controller	$13.00	DigiKey	568-9835-ND	1	$13.00	http://www.nxp.com/products/microcontrollers/core/cort
Newhaven Display Intl	Capacitive LCD Screen	$78.50	DigiKey	NHD-7.0-800480EF-ATXV#-CTP-ND	1	$78.50	http://www.digikey.com/product-search/en?keywords=N
	Plexiglass Surface						
	Wooden Encasement						
					Grand Total	$238.50	

Development Plan

Milestone	Start Date	End Date	Task	Person Responsible
Initial Design Review	10/12/2015	10/26/2015	Create powerpoint for system level design, including parts	Everyone
Milestone #3: System-Level Design	10/12/2015	10/26/2015		
			System Level Design	Everyone
			Component Selection	Everyone
			Bill of Materials	Philip
			Game board design	Philip
			LCD Touchscreen design	Jeremiah
			LED Design	Jason
			Sensor Design	Alex
			Collect Datasheets	Everyone
Milestone #4: Detailed Design	10/26/2015	11/23/2015		
			Schematic Drawings	Everyone
			Low level hardware implementation	Everyone
Preliminary Design Review		11/13/2015	Provide proof that the job can be done	Everyone
Critical Design Review	12/8/2015	12/8/2015	Demonstrate the design is complete, correct, and ready for fabrication	Specific duties shown in milestone 3
Milestone #5: Design Implementation	11/23/2015	12/11/2015		
			PCB	Everyone
			Final Schematics	Everyone
			Final BOM	Everyone

Technology Reuse

- LCD Display
  - Used in previous capstone projects (different size but same interface)
  - Drivers supplied by manufacturer
  - Processor has built-in LCD driver
- Multi-colored LED strip
  - Tutorials provided by Adafruit for implementation
  - Arduino experimentation and previous experience addressing LEDs individually

Critical Elements

- Smooth sensor interfacing for each individual tile & piece
  - Accurate IR proximity reading for when a player has removed a piece from the playing surface
    - Must recognize individual tiles and pieces separately to uniquely identify each game-tile
- Software logic to monitor and maintain piece locations in memory
  - Must track every piece’s movement and store its current location in memory to determine possible moves
    - Intuitive solution: All pieces start in the same position at the beginning of every game. Based on which sensor detects movement first, use that position as a basis for where that piece has moved and which pieces do not detect any objects above them to identify vacant tiles.
- LCD Interfacing and GUI Design
  - Simple and efficient display - Navigate between several displays